



DEFENSE INFORMATION SYSTEMS AGENCY  
JOINT INTEROPERABILITY AND ENGINEERING  
ORGANIZATION



**DEPARTMENT OF DEFENSE**  
**MILITARY STANDARD 2525**  
**COMMON WARFIGHTING SYMBOLOGY**  
**IMPLEMENTATION CONCEPT**



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## **EXECUTIVE SUMMARY**

This document outlines the process to necessary to effectively test and implement Military Standard (MIL-STD) 2525, "Common Warfighting Symbolology," Versions 1 and 2. It establishes procedures, assigns responsibilities, and presents a milestone plan that will result in the validation and acceptance by CINC/Service/Agencies (C/S/As) of common command, control, communications, computer, and intelligence (C4I) warfighting symbolology. This document applies to all DOD components directly or indirectly involved with C4I for the Warrior (FTW) operations, system operations, systems development, and training within the context of warfighting operations.

A Special Standards Coordinating Committee (SCC) was convened on 10 May 1994 to consider two issues raised by the Symbolology Standards Management Committee (SSMC). The first issue addressed resolution on geometric borders on which the SCC agreed to a compromise. The second issue addressed the Services' requirement for testing MIL-STD-2525 prior to implementation. The SCC supported the testing requirement prior to mandatory use by the Services in future and migrating C4I systems. The SCC tasked the SSMC to develop a concept of implementation, outlining the steps necessary to resolve the testing issue by developing an approach that will provide both the technical and operational testing required by the C/S/As. The SCC intends to provide this concept to the Interoperability Improvement Panel (IIP) of the Military Communications and Electronics Board (MCEB) as a plan for resolving the testing issue.

This implementation concept also provides background on the development of MIL-STD-2525, Version 1, recommends developing implementation policy in the form of a Chairman, Joint Chiefs of Staff Instruction (CJCSI), and recommends MIL-STD-2525 be incorporation into Department of Defense (DOD) migration strategies. It provides a test concept for MIL-STD-2525, and discusses the future development of Version 2 and its acceptance as a standard.

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## **SECTION 1 INTRODUCTION**

### **1-1 PURPOSE AND SCOPE**

This document outlines the process necessary to test and implement MIL-STD-2525, "Common Warfighting Symbology," Versions 1 and 2 effectively. It establishes procedures, assigns responsibilities, and presents a milestone plan that will result in the validation and acceptance by the C/S/As of a common set of command, control, communications, computer, and intelligence (C4I) warfighting symbols. It applies to all DOD components directly or indirectly involved with C4I for the Warrior (C4IFTW) operations, system operations, systems development, and training within the context of warfighting operations.

### **1-2 BACKGROUND**

A. The use of symbols in C4I is tied to traditions, traditional processes, and set ways of doing business. In the past, C4I systems have handled symbology uniquely and without standard and interoperable methods. This has been acceptable in the past but in an era of resolving interoperability issues "winning the battlefield information war will require some significant changes in the way we do business." DOD's increased emphasis on joint warfighting stresses the importance of interoperability within the C4I community of systems (reference a and b). MIL-STD-2525 addresses the basic symbol needs of the warrior and re-aligns the diverse traditional warfighting symbology into a new single symbol set with an associated coding scheme and information hierarchy.

B. The Military Communications-Electronics Board (MCEB) established a 90-day accelerated standardization process on 31 August 1993. This process allows for 30 days to develop a draft standard, 30 days for C/S/A review, 15 days for final corrections, and 15 days for C/S/A final concurrence/nonconcurrence. The MCEB gave the Standards Coordinating Committee (SCC) the task to develop a military standard for common warfighting symbology as the first standard to be developed using this accelerated process. The SCC, the standards body under the MCEB (reference c), received this assignment in September 1993. The SCC formed an ad hoc Symbology Working (WG) on 6 October 1993, and the C/S/As were asked to provide operational representatives to the working group. This WG was established formally as the Symbology Standards Management Committee (SSMC) on 9 February 1994. The WG/SSMC consensus was that two NATO Standardization Agreements (STANAGS), 2019 and 4420, (reference d and e) would form the basis for developing MIL-STD-2525. However, both conflicted in their use of basic symbols and geometric borders. STANAG 2019 focused on land based (units, forces, and equipment) symbology while STANAG 4420 addressed air and sea based (identification and tracking) symbology. Neither completely addressed joint warfighting in a land, sea, and air environment. The impact is not so much on automation but on people and training. The Services and allies do not have a common, interoperable symbol set. Change is necessary to meet the cross Service/allied needs of a modern digitized battlefield.

C. During its design and development, the SSMC was able to reach a consensus on the majority of the content of MIL-STD-2525. However, unanimous agreement on basic geometric border shapes could not be reached. Army and Navy human factors engineering laboratories developed a human-oriented solution for the geometric borders. The final draft of MIL-STD-2525, Version 1, was distributed with this solution on 9 February 1994 at the SCC. At that meeting, the Chairman of the SCC and SSMC expressed concern to the representatives of the C/S/As that operators should be more involved in the accelerated standards development process. A SSMC was held on 28 April 1994, in which most issues were resolved. The geometric border issue and the issue of operational assessment were brought to the SCC on 3 May 1994. A special SCC met on 10 May 1994 to resolve these issues. The special SCC resolved the geometric border issue through a compromise set of borders. The task to develop this implementation concept to address the issue of operational assessment was given to the SSMC at this meeting. This concept represents the consensus developed in a series of SSMC meetings beginning on 24 May 1994.

D. The C/S/A review of the MIL-STD-2525, Version 1, dated 16 May 1994, which incorporated SCC geometric border solutions, was completed on 24 June 1994. Version 1 will become a military standard after being processed through the Information Standards Technology (INST) Lead Standardization Activity (LSA) (reference f), and is scheduled to be published by 30 September 1994. The C/S/As do not support mandatory use of MIL-STD-2525 until it is validated in an operational test. This implementation concept, developed by the SSMC, includes policy, migration, operational assessment, and post standard actions required to implement the common warfighting symbology within the DOD. The MCEB received a decision brief on this implementation concept on 25 July 1994. The MCEB concurred in approving MIL-STD-2525 without further review. The MCEB also concurred in forwarding the implementation concept to the Interoperability Improvement Panel (IIP) for action.

## **SECTION 2 APPROACH**

### **2-1 OVERVIEW**

Symbols are an integral part of C4I. They transcend all three hierarchical categories of the warrior's C4I infrastructure: warrior's terminal, warrior's battlespace, and the infosphere. Symbolology is involved in basic warrior operations and interaction with information. Symbols act to fuse the battlespace for the warrior in multiple domains, including force and engagement domains. They transcend all aspects of the infosphere (information, information processing, and information transfer), and they are battlespace information. As such, C4I systems must be designed and implemented to allow the warrior to define his or her own battlespace in an efficient, effective, and standardized way of doing business. To move from the diverse symbolology used throughout the DOD, change must be deliberate and planned. This concept includes the necessary policy documentation, testing, follow-up development, and configuration management that will allow a deliberate, planned implementation of common symbolology within the DOD. Along the implementation of MIL-STD-2525, consideration of other symbolology standardization efforts must be included to ensure DOD systems are interoperable.

### **2-2 POLICY DOCUMENTATION**

A. The implementation of MIL-STD-2525 will require clear policy from the Joint Staff in the form of a Chairman, Joint Chiefs of Staff Instruction (CJCSI). The CJCSI must incorporate several key points in the implementation policy that will place MIL-STD-2525 into the hands of the warrior. The SSMC has recommended that the following be considered:

1. A CJCSI must be published in a time consistent with the publishing of MIL-STD-2525, Version 1, but no later than October 1994. This CJCSI should state that:

a. MIL-STD-2525, Versions 1, upon acceptance of a validation test (operational assessment), and Version 2, will serve as the baseline for all future C4I systems in the presentation of situation displays in support of joint operations centers, and for migrating C4I systems where practical.

b. MIL-STD-2525 is recommended for use for all tactical displays, to include electro-optical cockpit displays where practical. MIL-STD-1295 (reference g) and MIL-STD-1787B (reference h) will, however, continue to provide the standard guidance regarding rotary and fixed wing cockpit displays.

2. MIL-STD 2525, Version 2 should be developed concurrent with the design of a certification test for systems incorporating MIL-STD 2525 symbolology. The SSMC recommends that the CJCSI should state that all C4IFTW systems be certified using these tests by the DISA, Joint Interoperability Test Center (JITC) prior to deployment as operational systems.

3. Future symbology standards processed through the SSMC should be incorporated in the standard symbology for DOD C4IFTW.

B. The proposed CJCSI must incorporate other standardization efforts into MIL-STD-2525 implementation.

1. The CJCSI should state that systems that must comply with NITFS will use MIL-STD-2525 icon identifiers. Symbols will comply with CGM as specified in MIL-STD-2301.

2. The CJCSI should state that, where possible, C4I systems will adopt the icon construction software module developed by the ASPO.

C. MIL-STD-2525, Version 1, will provide the basis for the U.S. position to NATO standards bodies.

D. STANAG 1241 (reference i) serves as the basis for the definitions for track affiliation (e.g., hostile, friendly, etc.).

## **2-3 MIGRATION**

MIL-STD-2525 will be incorporated into DOD's migration strategy for all C4I systems (e.g., Global Command and Control System). Through appropriate CJCS policy, J6 should insure that MIL-STD-2525 becomes an integral part of all migrating and future systems. Exceptions to this standard symbology should be granted on a very limited basis with specific cause. JCS (J2/J3/J7/J8) must ensure operational use, doctrinal incorporation, and training of the MIL-STD-2525 symbol set, to include incorporation into modeling and simulation systems.

1. The Symbol Coding Schema (icon identifiers) from MIL-STD-2525, will be incorporated into MIL-STD-2500, National Imagery Transmission Format for the National Imagery Transmission Format Standards (NITFS) (reference j). This will ensure that imagery and map backgrounds use MIL-STD-2525 in a standard method. The NITFS Technical Board has concurred with the recommendation and the one that follows.

2. Further, symbols stored and/or provided to users must be in a common format in compliance with the NITFS, specifically MIL-STD-2301 (reference k), Computer Graphics Metafile (CGM) Implementation Standard for the National Imagery Transmission Format Standard.

3. A DOD symbol database using the symbol coding schema from MIL-STD-2525 and in MIL-STD-2301 compliance should be developed and configuration managed by the Defense Information Systems Agency (DISA), Center for Standards.

4. The Joint Graphical Situation Display (GSD) or the icon construction

software module from the GSD should be incorporated into as many open C4I systems as possible. This system, developed for the Assistant Secretary of Defense for Command, Control, Communication and Intelligence (ASD/C3I) by the Army Space Program Office (ASPO), is government-owned software available at no cost to the users. The GSD software can construct MIL-STD-2525 symbols using the coding schema of MIL-STD 2525 and in compliance with MIL-STD-2301.

5. Data associated with symbols (e.g. fields) must incorporate the standard C2 data elements (reference l and m).

6. C4I symbology modeling and simulation communities should conform to MIL-STD-2525 to align with the operational community.

7. U.S. Message Text Format (USMTF) based symbol coding must be developed for MIL-STD-2525 symbology.

8. Training requirements associated with implementation of MIL-STD-2525 must be incorporated into the C/S/A training programs for the implementing C4I systems.

9. The costs associated with retraining system users, documenting test and system implementations, and changing of system capabilities to allow use of MIL-STD-2525 must be evaluated in a cost/benefit analysis to ensure funding will allow useful integration into fielded systems.

## 2-4 VALIDATION (OPERATIONAL ASSESSMENT) AND CERTIFICATION TESTING

A. Implementation of MIL-STD-2525 requires two types of testing (figure 1): validation and certification.

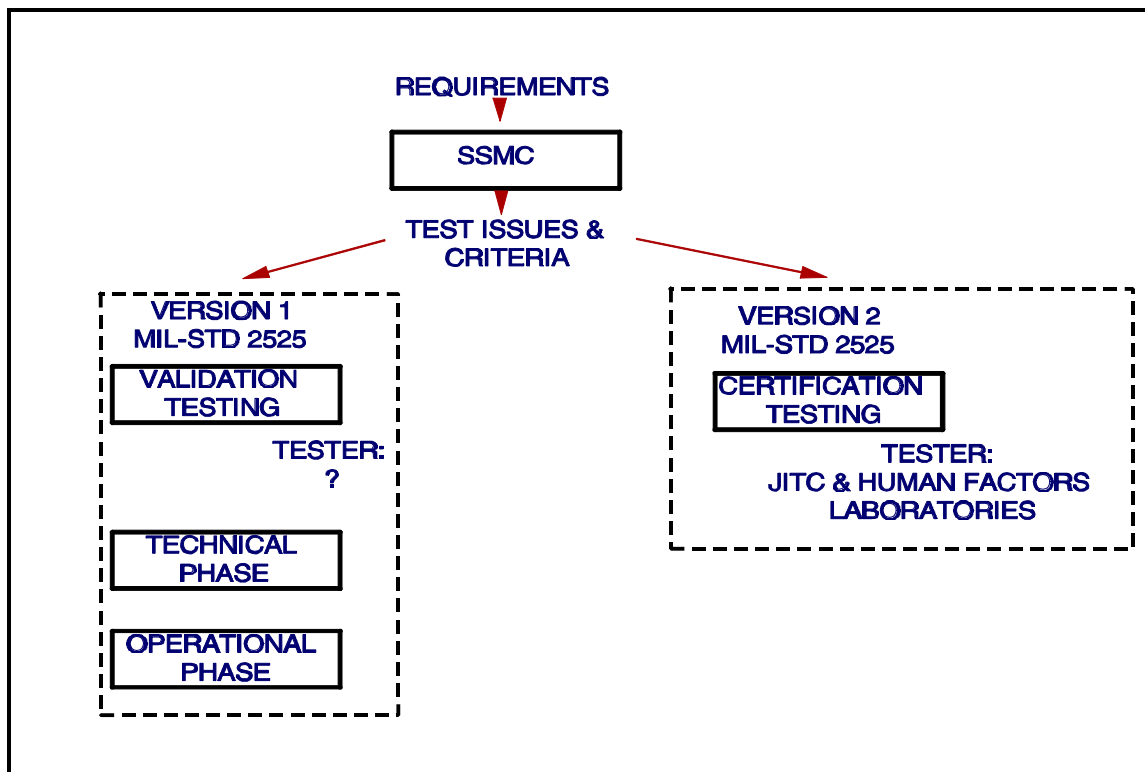


Figure 1. Types of Testing

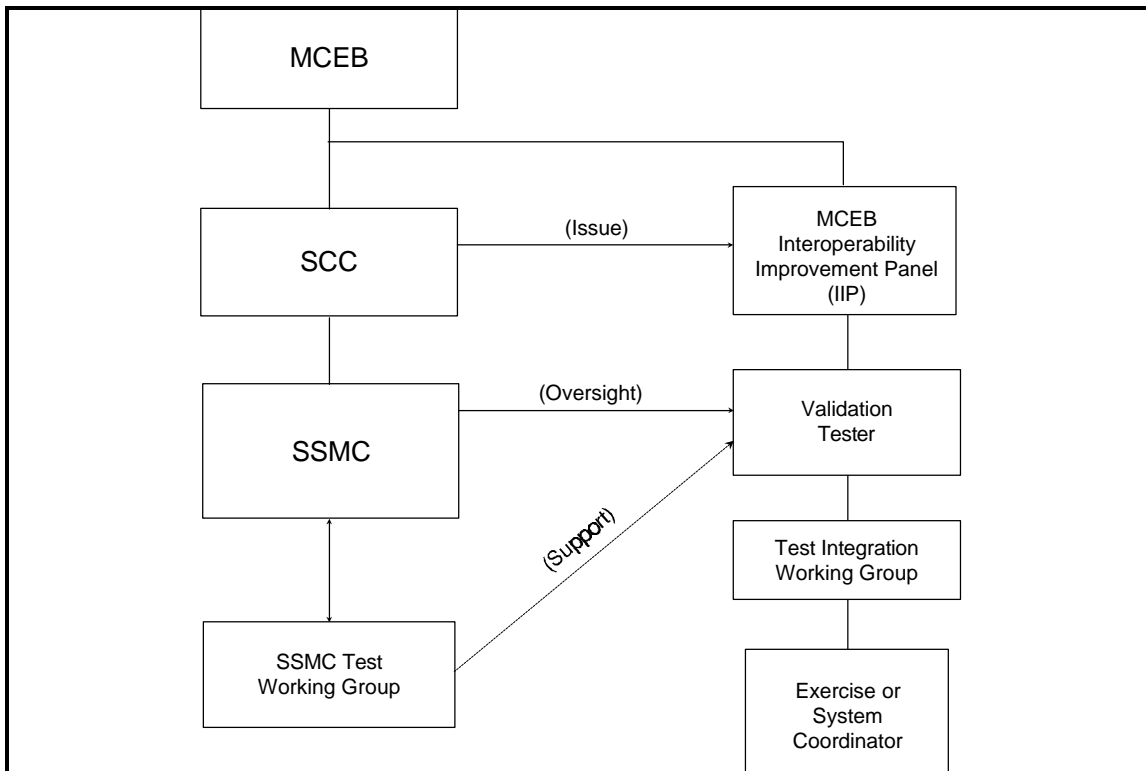


Figure 2. Validation Testing

1. Validation testing (including operational assessment) proves the physical realization and clarity of the military standard (MIL-STD). All information technology (IT) standards developed or adopted under the IT Standards Program undergo some form of testing (often referred to as validation) either as a part of a system implementation conformance, or as part of other standards-related activities. JITC is responsible for establishing a comprehensive testing program for supporting information technology system standards. Due to its potential impact on operations, an operational assessment of MIL-STD-2525, Version 1, is also necessary prior to making it mandatory for C/S/A compliance. Using the IT standards management structure currently in place (reference c), figure 2 provides a mechanism which addresses validation testing.

In the above scenario, the SSMC develops the implementation concept (IC) and forwards it to the SCC. The SCC conducts a 30 day review of the IC and makes a decision whether or not to forward the IC to the MCEB/IIP as an issue. The IIP takes the IC on as an action and appoints a tester. The IIP appoints a tester who conducts the validation test. The SSMC Special Test Working Group assists the tester in the development of test criteria and the conduct of the test. The tester forms a Test Integration Working Group (TIWG) to oversee the test.

2. Certification testing proves that a product or system conforms to a validated standard. Certification testing is a mission of the JITC (reference n). A certification procedure plan will be completed during the development of Version 2 of MIL-STD 2525. Figure 3 provides an overview of the certification testing process.

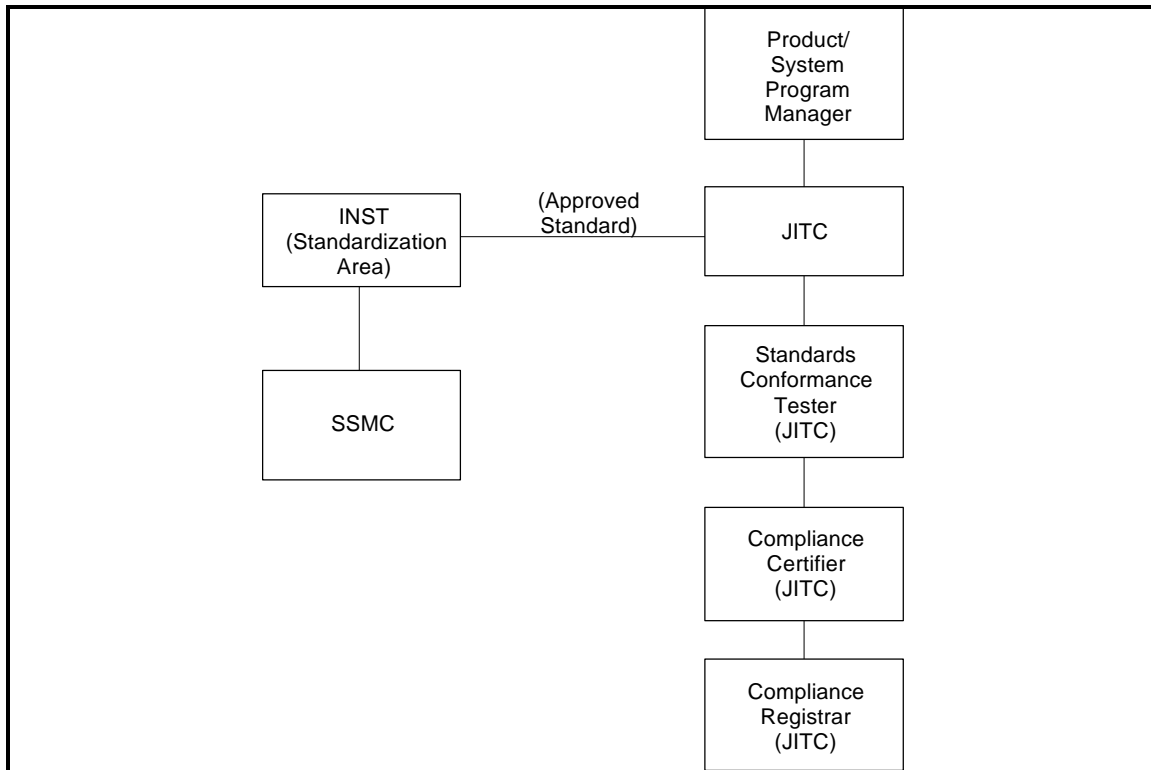


Figure 3. Certification Testing

#### B. Validation Testing (Operational Assessment)

1. An operational assessment of MIL-STD-2525 is required prior to its adoption for mandatory use to ensure the usability of the symbology by the C/S/As. The SSMC developed a testing concept as part of this implementation concept, which consists of a multi-service, operational assessment designed to answer a specific set of issues and criteria. The SSMC recommends that the test scenario be a joint scenario involving all Services, with a Joint Task Force (JTF) conducted in conjunction with a planned joint exercise, demonstration (e.g., Joint Warrior Interoperability Demonstration), or other joint simulated demonstration (e.g., using Distributed Interactive Simulation).

2. The SSMC has developed the following test issue and criteria for testing MIL-STD-2525 implementation. Appendix C contains test issues and criteria which must be considered in the development of specific test criteria.

a. ISSUE: Are the C4IFTW operations and system needs for a standard set of Joint symbology met by MIL-STD-2525?

(1) CRITERION 1: (Technical)

(a) Does the symbology meet human factor (HFAC)

concerns of perceptibility and discriminability?

-- Perceptibility is the ability to acquire and process symbols. Specific areas to be tested are an individual's ability to search and acquire specified symbols after learning.

-- Discriminability is the ability to distinguish among symbols and depends on future similarity among symbols. Clutter testing will examine the ability of an individual to discriminate specific symbols with varying degrees of visual competition from multiple symbols. Confusion testing will examine the ability of an individual to discriminate specific symbols when they are with other symbols.

(b) The technical test should include a comparison with three existing symbol sets: Navy Tactical Display System (NTDS), FM 101-5-1 (reference o), and MIL-STD 1477B (reference p).

(c) Specific pass and fail measures will be developed by a Special Test Working Group formed under the SSMC.

b. ISSUE: Is the symbology usable in automated tactical C4I display systems, on aircraft cockpit displays, and in a manual mode?

#### CRITERION 2: (Operational)

- This criterion will examine three methods of symbol use and will be combined with Criteria 3 when tested. The purpose is to ensure that a user in any of the three modes can use the new symbology. A Special Test Working Group formed by the SSMC will develop measurements and pass/fail conditions.

c. ISSUE: Is the symbology usable in a Joint scenario?

#### CRITERION 3: (Operational)

- Criterion 3 will be tested at the same time as Criterion 2. The Special Test Working Group formed by the SSMC will define specific measures and pass/fail conditions associated with testing Criterion 3.

d. The SSMC recommends that a single test director from the testing organization be appointed, with one activity in charge of the entire test. This should include planning, conducting, and reporting. The J6 should maintain oversight with the SSMC used as a technical asset. A Test Working Group from the SSMC should be formed to review the test plan, monitor the test, and resolve issues arising from the test. The Special Test Working Group from the SSMC

should be an integral part of a Test Integration Working Group (TIWG) that oversees all aspects of the test. The following organizations are recommended as potential testers in the priority shown:

(1) Joint Interoperability Test Center (JITC)

(2) Joint Warfighting Center (JWFC)

(3) A Service operational Test Activity (e.g., US Army Operational Test and Evaluation Command (USAOPTEC), Commander Operational Test and Evaluation Forces (COMOPTEVFOR), Marine Corps Operational Test and Evaluation Command (MCOTEA), or Air Force Operational Test and Evaluation Command (AFOTEC)) acting as the lead service for the test.

e. Based on testing NATO STANAG 4420, the SSMC has estimated that test costs could reach as high as \$3 million plus additional dollars needed to incorporate the symbol set (software) into the systems used in the test. This estimate is only an order of magnitude estimate and will vary depending on many factors (e.g., "piggy backing" on other exercises or demonstrations). The tester must be given some latitude in the costing of the test. The SSMC consensus is that the Joint Staff should provide the necessary funds, possibly interoperability dollars.

f. The SSMC has estimated that 12 months will be necessary to conduct this test. The start of the test depends on the availability of resources and the ability to incorporate testing into planned exercises and activities. Time must be allowed for incorporating MIL-STD-2525 symbology (software) into systems used in the test. The GSD software developed by the ASPO may provide the most cost effective means for incorporating these symbols into UNIX-based systems. Training on the new symbol set also may be required. All testing should be conducted in an unclassified mode. The SSMC recommends a two-phased approach to the test based on the issue and criteria developed by the SSMC. The major milestones for the operational assessment are described below in figure 4.

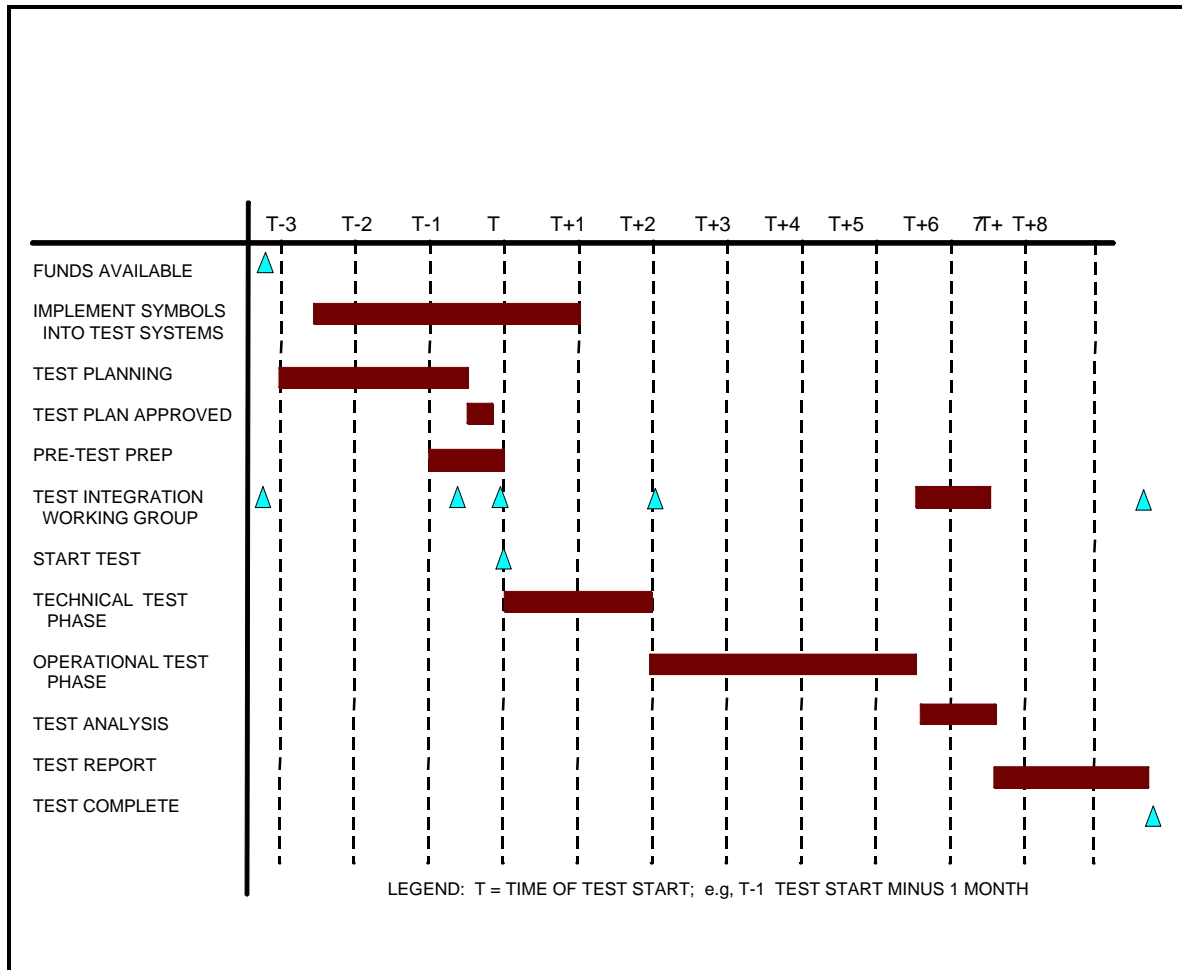


Figure 4. Milestone Plan

Recommended time periods and dates are provided in Table 1 below.

Table 1. Recommended Test Dates

Activity	Projected Duration (days)	Recommended Completion Date
Implementation of symbols into test systems; development of training package	30 - 120	December 1994
Test plan development	75	December 1994
Test plan approval	15	April 1995
Pre-test preparation	30	May 1995
Technical Test Phase (Criterion 1)	60	June 1995
Operational Test Phase (Criterion 2 and 3)	105	August 1995
Test analysis	30	October 1995
Test report	60	November 1995

g. When testing is complete, the analysis of the results should be completed by a data analysis group consisting of the test team, SSMC Test Working Group, and Joint Staff, each having one vote to resolve differences. The results should be briefed to the IIP, SCC, MCEB, and Intelligence Systems Board (ISB). These will be decision briefings and will constitute Service acceptance of the standard.

h. Changes resulting from the testing should be identified as critical or non-critical. Critical changes will be implemented immediately into Version 1 of the standard. All other changes will be incorporated into Version 2 of the standard. Proposed changes resulting from the testing will be coordinated through the SSMC for service review and concurrence. Recommendations for improvements will be collected during operational assessment for consideration in Version 2.

i. MIL-STD-2525 (Version 1) will become mandatory upon completion of the decision briefings.

j. The tester will place a configuration control on the standard and its implementation in the systems being tested. MIL-STD-2525 will be in a frozen configuration status until the test is completed. Only changes required to complete the testing will be allowed. The test director will be the sole decision authority on changes and must document any and all changes carefully. Where possible the impact on the test will be determined.

k. The Test Integration Working Group should be the final authority for test decisions.

## 2-5 OPTIONS

The SSMC has developed several options for conducting the Validation Testing that may save funds and time. These are discussed here.

A. Technical Test Phase. Recommend that the Naval Post-Graduate School be approached to conduct the Technical Test Phase in the form of student projects. A special Test Working Group to the SSMC with human factors experts from the services could serve as an advisory group to the student projects.

B. Operational Test Phase. Recommend use of projected Global Command and Control System (GCCS) components as a vehicle for validating MIL-STD-2525 prior to making its implementation mandatory. The GCCS Migration Manager (MM) could use in projected GCCS components for the first implementation of MIL-STD-2525. The Joint Staff must fully support and fund the testing. The following approach could be taken.

1. Identify key potential components of GCCS and implement MIL-STD-2525 into one or two of the components. A list of recommended systems follows in Table 2 below.

Table 2. Recommended GCCS Components.

FUNCTION	SERVICE	SYSTEM
Command, Control, Intelligence	Army	All Source Analysis System (ASAS) Standard Theater Army Command and Control System (STACCS)
Control System	Air Force	Contingency Theater Automated Planning System (CTAPS)
Joint Information System	Navy	Joint Maritime Command Information System (JMCIS)
Joint Information System	Marine Corps	Marine Air-Ground Task Force (MAGTF) -Tactical Combat Operations (TCO)

2. Appoint a single tester from the MM, GCCS.

3. Use an abbreviated version of an exercise for a test scenario (e.g., an abbreviated portion of the Joint Warrior Interoperability Demonstration).

4. Form a special Test Working Group from the SSMC members to provide technical support to the test and to resolve issues for inclusion in Version 2 of MIL-STD-2525.

5. Recommend using the ASPO developed GSD as the implementation software module for the standard in each of the recommended systems. All are UNIX-based, open system architectures.

6. Follow a similar set of milestones for the test plan as in paragraph 2-4. Where possible, the symbology testing should be made part of other ongoing GCCS efforts.

7. Apply other areas in paragraph 2-4 as practical.

The participants and scope of the test should be defined by the MM, GCCS and the appointed tester.

## **2-6 VERSION 2 DEVELOPMENT**

A. Version 2 of MIL-STD-2525 will be completed within two years of the approval date of Version 1 in accordance with DoD Manual 4320.3-M. Version 2 will include developing certification testing of systems using MIL-STD-2525, but will not undergo an operational assessment as in Version 1. The milestones for developing Version 2 are included in the Symbology Information Technology Standards Management Plan (reference q). Key milestone dates for MIL-STD-2525, Version 2, are provided in Table 3.

Table 3. Milestones - MIL-STD-2525, Version 2.

<b>MIL-STD-2525, Version 2</b>	<b>Target Completion Date</b>
Initiate development	October 1994
First Draft	October 1995
Second Draft	January 1995
Final Draft	March 1996
Publish	May 1996
Develop symbol database	May 1996

### **B. Certification Testing**

1. The Joint Interoperability Testing Center (JITC), with assistance from the Service human factor laboratories (the Navy's Naval Air Warfare Center, Air Vehicle and Crew Systems

Technology Department, and the Army's U.S. Army Research Laboratory) are tasked with the development of a certification test for MIL-STD-2525, Version 2.

2. Testing will ensure products' and systems' compliance with Version 2. The end result will be JITC certification of the product and system as interoperable and compliant with the MIL-STD.

3. The certification test development will be a parallel effort with development of Version 2. It is currently funded through 30 September 1995. Joint Interoperability and Engineering Organization (JIEO) and the Service human factor labs are tasked to complete the plan and set up for customer funded testing upon approval of Version 2.

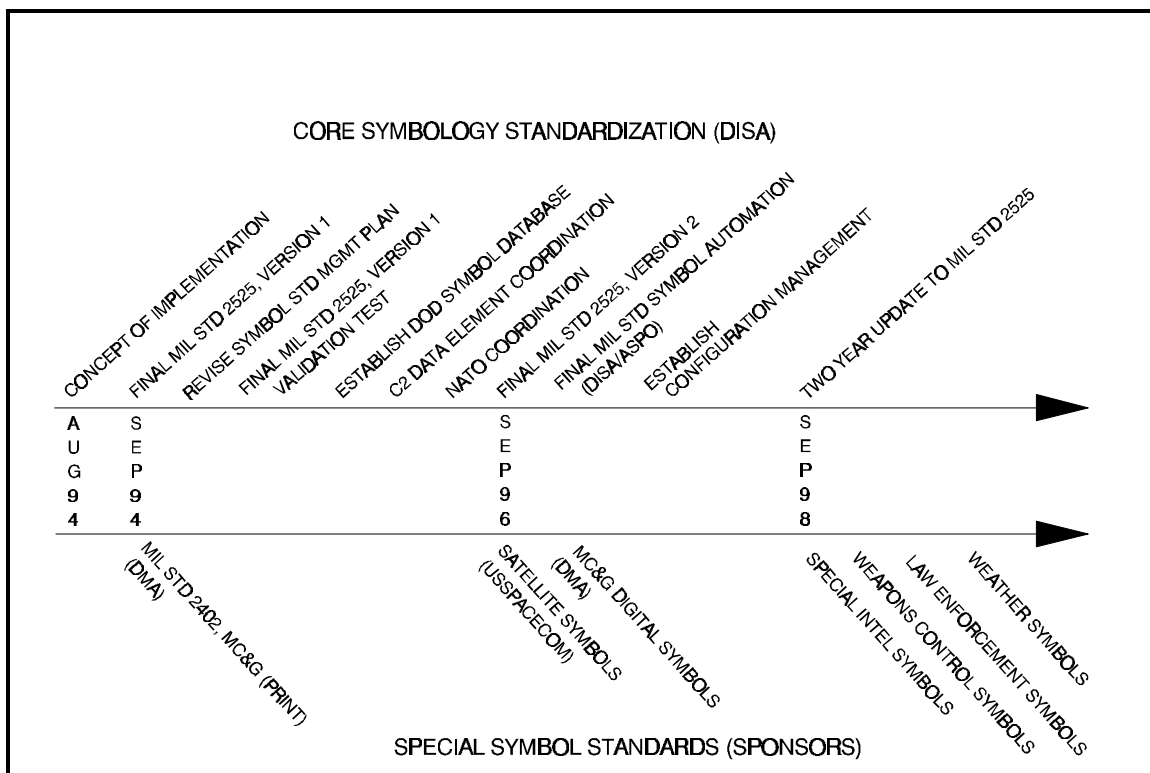


define, and document the process. These steps are defined in reference a.

## SECTION 4 SUMMARY

### 4-1 FAMILY OF SYMBOLOGY STANDARDS

The SSMC prepared a draft Symbology Information Technology Standards Management Plan (SITSMP) (reference q) that relates MIL-STD-2525 development to actions deemed necessary to standardize symbology within DOD. The family of symbology standards referred to in figure 6 includes a set of base documents necessary to manage the symbology standardization effort as well as two base military standards (MIL-STD-2525 and MIL-STD for Symbol Automation). The other documentation consists of a database specification for a DOD symbol database and a configuration management plan for managing symbols and symbology standards. The SSMC recommends funding the development of a symbol database, the associated documentation, and a configuration management plan consistent with the Information Technology Standards Management Plan (ITSMP) (reference c).



**Figure 6. Symbology Standards**

Special symbol sets will be developed to meet the warrior's symbol requirements. Three such symbol sets are being developed. The Defense Mapping Agency (DMA) is staffing MIL-STD 2402,

*Mapping, Charting, and Geodesy (MC&G) Symbolology for Graphic Products* (reference s), for C/S/A review. DMA also is working on a military standard to address MC&G digital symbolology. The US Space Command is preparing a special symbol set for satellite control. Other proposed symbol sets have not been funded or assigned to preparing activities (e.g., special symbol sets for intelligence or weather). The SSMC recommends that the evolving SITSMP be an integral part of the implementation of MIL-STD-2525.

#### 4-2 IMPLEMENTATION POLICY

The SSMC felt that standard symbols for the warrior are critical for eliminating the fog of battle and ultimately can save lives. The SSMC feels symbolology standardization deserves a high level of attention and should be funded adequately to ensure that usable symbolology standards are available to the warrior. Service acceptance of the symbolology standardization effort, especially the first critical standard (MIL-STD-2525), is essential if a strong, interoperable symbol foundation is to be established across the C4IFTW hierarchy. Key to this success is the effectiveness of the policy that implements and guides the symbolology standardization effort.

## APPENDIX A

### REFERENCES

- a. DODD 4630.5, *Compatibility, Interoperability, and Integration of Command, Control, Communications, and Intelligence (C3I) Systems*, 12 November 1992.
- b. DODD 4630.8, *Procedures for Compatibility, Interoperability, and Integration of Command, Control, Communications, and Intelligence (C3I) Systems*, 18 November 1992.
- c. JIEO Plan 3200, *Information Technology Standards Management Plan*, November 1993.
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- e. STANAG 2019, "Military Symbols for Land Based Systems."
- f. DOD 4120.3-M, *Defense Standardization and Specification Program Policies, Procedures, and Instructions*, July 1993.
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- i. STANAG 1241, "NATO Standard Identity Description Structure for Tactical Use."
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- o. FM 101-5-1, *Operational Terms and Symbols*, October 1985.
- p. MIL-STD-1477B, *Symbols for Army Air Defense System Displays*, 30 September 1993.
- q. JIEO Plan 9XXXX, *Symbolology Information Technology Standards Management Plan*

(ITSMP) (Draft), 30 September 1993.

r. MIL-STD-973, *Configuration Management*, 17 April 1992.

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## APPENDIX B GLOSSARY

### B-1 ACRONYMS

AFOTEC	Air Force Operational Test and Evaluation Command
AHWG	Ad Hoc Working Group
ANSI	American National Standards Institute
ASD(C3I)	Assistant Secretary of Defense for Command, Control, Communication and Intelligence
ARPA	Advanced Research Projects Agency
ASAS	All Source Analysis System
ASPO	Army Space Program Office
CCB	Configuration Control Board
CFS	Center for Standards
CGM	Computer Graphics Metafile
CIM	Corporate Information Management
CINC	Commander-in-Chief
CJCS	Chairman Joint Chiefs of Staff
CJCSI	CJCS Instruction
CM	Configuration Management
COMOPTEVFOR	Commander Operational Test and Evaluation Forces
C/S/A	CINC/Services/Agencies
CTAPS	Contingency Theater Automated Planning System
C3I	Command, Control, Communications, and Intelligence

C4I	Command, Control, Communications, Computers, and Intelligence
C4IFTW	C4I for the Warrior
DISA	Defense Information System Agency
DOD	Department of Defense
DODD	Department of Defense Directive
DODI	Department of Defense Instruction
DMA	Defense Mapping Agency
DSP	Defense Standardization Program
EA	Executive Agent
FIPS	Federal Information Processing Standard
FSC	Federal Supply Category
FSG	Federal Supply Group
GCCS	Global Command and Control System
GSD	Graphic & Situation Display
HFAC	Human Factors
ICS	Intelligence Community Staff
INST	Information Standards
IIP	Interoperability Improvement Panel
ISB	Intelligence Systems Board
ITS	Information Technology Standards
ITSP	Information Technology Standards Program
ITSMP	Information Technology Standards Management Plan

JCS	Joint Chiefs of Staff
JIEO	Joint Interoperability and Engineering Organization (formerly JTC3A)
JITC	Joint Interoperability Test Center
JMCIS	Joint Maritime Command Information System
JTF	Joint Task Force
JWFC	Joint Warfighting Center
LSA	Lead Standardization Activity
MAGTF	Marine Air-Ground Task Force
MIL-STD	Military Standard
MCEB	Military Communications-Electronics Board
MC&G	Mapping, Charting, and Geodesy
MCOTEA	Marine Corps Operational Test and Evaluation Command
MM	Migration Manager
NATO	North Atlantic Treaty Organization
NGS	Non-Government Standard
NITFS	National Imagery Transmission Format Standards
NTDS	Navy Tactical Display System
NRaD	Navy Research and Development Center
SCC	Standards Coordinating Committee
SD	Standardization Document
SITSMP	Symbology Information Technology Standards Management Plan
SSMC	Symbology Standards Management Committee

STACCS	Standard Tactical Army Command and Control System
STANAG	Standardization Agreement
TIWG	Test Integration Working Group
USAOPTEC	US Army Operational Test and Evaluation Command
USMTF	US Message Text Format
WG	Working Group

## B-2 DEFINITIONS

Configuration Management (CM). As applied to configuration items, a discipline applying technical and administrative direction and surveillance over the life cycle of items to identify and document the functional and physical characteristics of configuration items, to control changes to items and documentation, to record and report information, and to audit items to verify conformance to specifications, drawings, interface control documents, and other contract requirements.

Confusion Matrix. A matrix that reflects the number of times a symbol is mistaken or confused with another. This matrix is developed during the conduct of a test (in a controlled environment) given to a specified user group for the purpose of determining what symbols are being confused with each other and the subsequent impact of these errors.

C4IFTW. A vision or concept that provides the warrior at any time and place with a fused, real-time, true representation of the warrior's battlespace.

Discriminability. The ability to distinguish among symbols; depends on future similarity among symbols.

Human Factors (HFAC). Human factors engineering incorporates human characteristics and considerations into the design of military systems, equipment, and facilities. The HFAC standardization area includes tasking requirements and technical data for analysis, design test, and evaluation during acquisition. It also includes design criteria, expressed as requirements and guidelines, as they apply to those who will operate, control, maintain, supply, or transport the material. HFAC also encompasses environmental considerations including limits for maximum exposure, human performance, habitability, and vulnerability. Manpower, personnel, and training considerations apply only to the degree that they affect the human performance aspects of design.

Information Technology Standards (ITS). ITS provide technical definitions for information system processes, procedures, practices, operations, services, interfaces, connectivity,

interoperability, information formats, interchange, and transmission/transfer. ITS apply during the development, testing, fielding, enhancement, and life cycle maintenance of DOD information systems.

Information Standards and Technology (INST). INST constitutes the standardization area that encompasses development, coordination, and integration of standardized information components across all functional areas within DOD. It includes report standards, data exchange format standards, operational instructions, symbology standards, and geographic, graphic, and imagery constructs.

Interoperability. The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate together effectively.

Lead Standardization Activity (LSA). An LSA is a management activity within a military department or Defense agency that guides DOD standardization efforts for an FSG, an FSC, or a standardization area through the development of standardization program plans, authorization of standardization projects, and identification and resolution of standardization issues. The SD-1 (reference d) identifies the LSAs.

MC&G Symbology. MC&G symbology represents natural and man-made features used in producing or displaying maps, charts, and digital geospatial information.

Meteorological Symbology. Meteorological symbology is used in weather/climatic forecasting.

Perceptibility. Perceptibility is the ability to acquire and process symbols.

Standard. A standard is a document that establishes uniform engineering and technical requirements for processes, procedures, practices, and methods. Standards also may establish requirements for selection, application, and design criteria of material.

Standardization. Standardization is the process of developing and agreeing upon uniform engineering criteria (by consensus or decision) for products, processes, practices, and methods.

Standardization Areas. Standardization areas are categories for engineering technologies, disciplines, and practices that do not fall under a Federal Supply Category (FSC), a Federal Supply Group (FSG). The SD-1 (reference d) identifies the Standardization Areas.

Standardization Document. A standardization document is used to standardize an item of supply, process, procedure, method, data, practice, or engineering approach. Standardization documents include military specifications, standards, handbooks, and bulletins; federal specifications and standards; guide specifications; CIDS; and Non-Government Standards (NGSs).

Standardization Program Plan. A standardization program plan is a document prepared by an LSA that identifies standardization opportunities, problems, and objectives, and establishes milestones for accomplishing standardization goals and specific tasks in a FSC, FSG or a standardization area.

Standardization Project. A standardization project is an effort approved by the cognizant LSA to develop, update, cancel, or adopt a standardization document, or conduct an item reduction study or engineering practice study.

Symbol. A symbol is an object which presents information.

Symbol Hierarchy. A structure developed to classify and organize a set of symbols. Appendix B, MIL-STD-2525 contains a symbol hierarchy developed for C4I symbols.

Tactical Graphics. A series of graphics (point, line, area-space, and volume-space) used to display and/or control the tactical situation or battlespace.

Warfighting Symbolology. Warfighting symbology is used in to plan and execute military operations in support of C4I functions and activities.

## APPENDIX C

### TEST REQUIREMENTS

1. Validation (Operational Assessment) of MIL-STD 2525, "Common Warfighting Symbolology," will be conducted prior to mandatory implementation. Operational assessment will be carried out in two phases: technical and operational. Certification testing proves that a product or system conforms to a validated standard. The interaction of symbolology with complex tactical graphics will have to be validated through validation testing. All testing will be conducted in an unclassified mode.

2. General Testing Methodology.

A. Recent investigations carried out by the US Navy Space and Naval Warfare Systems Command (SPAWAR) and the Advanced Research Projects Agency (ARPA) are of particular relevance to MIL-STD-2525 validation testing. The Symbolology Optimization and Display Advancement (SODA) project was conducted to evaluate the NATO STANAG 4420 maritime symbolology and to provide data on which the Navy could base the decision whether to ratify the NATO standard. The iconic symbol and identity color coding properties of STANAG 4420 symbolology were compared with the currently used NTDS symbol set. Experimental software was used to present a scenario which provided a variety of surface and air tracks and was presented dynamically on the CRT to realistically simulate a changing tactical situation. The results of this test (reference t) should serve as a basis for MIL-STD-2525 testing. The scenario was fixed but the tracks were represented on the CRT using different symbolology. Similar dynamic and realistic scenario presentations and automated collection of objective performance data (time and error data) are requirements for MIL-STD-2525 validation testing.

B. The electronic display medium for testing MIL-STD-2525 symbolology must be a computer driven CRT which simulates certain aspects of a tactical work-station. The useability of these symbols in a manual mode must also be addressed. Some elements of the contents of the experimental display will include:

Scenario - The scenario and corresponding displays must involve an amphibious assault planned and executed by a Joint Task Force element that includes air, ground, naval, and special operations (e.g. PRAIRIE WARRIOR).

Graphics - Standard Defense Mapping Agency (DMA) electronic map data (ADRG or CADRG) at both the tactical and planning scales will provide background. Symbolology and tactical graphics will be displayed using the Graphical Situation Display (GSD) software package currently under development (available October 1994) and/or others as appropriate.

Dynamic Scenarios vs Static Displays - Both dynamic scenarios and static displays should be used to realistically test tracking situations in combat and command and control of forces.

Close Control Information Area - Amplifying information on a track which is currently hooked will appear in the closed control information area, and will provide the operator with a realistic capability to answer test questions associated with that track.

Test Question Area - Test questions facilitating operator/test interaction should appear in a dedicated area at the top of the screen.

3. Specific testing requirements must be addressed. As a minimum, the following requirements are to be addressed during validation testing of MIL-STD-2525.

A. Symbol discriminability and confusability. Symbol discriminability refers to the ability of a suitably trained warrior to selectively attend to the symbol of a given track when that track is of a tactical interest. The operational definition of symbol discriminability is that a user who is instructed to hook the symbol for a given track class (such as hostile fighter aircraft) will, without error, designate the correct symbol on a display. Symbol confusability is the converse of symbol discriminability. If a user is instructed to designate the symbol for a given track class and, in fact, designates some other symbol on a significant proportion of trials, then this indicates that confusability exists between the symbols.

(1) Discriminability testing - Typical symbology and users should be tested on the full range of MIL-STD-2525 symbols with the intent to obtain empirical confusion matrices for the symbology which quantify the probability that when a given symbol is the recognition target, it is confused with another symbol. Testing should include a comparison of performance with current or existing symbol sets and the testing of a full symbol hierarchy, from complex to simple. Testing of all possible MIL-STD-2525 symbols is not practicable or necessary. If a given symbol is judged to have no associated confusion symbols, it can be dropped from the test.

(2) Special point symbol confusability. A number of special point symbols used in MIL-STD-2525 are visually similar. This test issue is logically subsumed under the general symbol discriminability issue discussed above, but is listed here to ensure that it receives due emphasis.

(3) Positive and Negative Transfer of Training. Positive transfer will be expected to the extent that MIL-STD-2525 symbols for a particular contact category are perceptually similar to the corresponding current symbols. Negative transfer will be expected to the extent that MIL-STD-2525 symbols are different from the current symbols for a given contact category or are perceptually similar to current symbols for other contact categories. Positive transfer will facilitate learning and performance when the MIL-STD-2525 symbols are introduced. Negative transfer will be expected to lead to user errors in symbol recognition and a need for re-training. The approach to testing will depend on the prior symbology experience on the user. Do users from the various C/S/As have homogeneous symbology experience? How many distinct user groups exist with regard to homogeneous symbology experience? The answers to these questions will determine the number of user group to be tested. The methods for discriminability testing addressed in paragraph A above should be applied to the groups of test subjects defined. Depending on C/S/A functions

and duties, subjects within a user group may not need to recognize certain MIL-STD-2525 symbols. Test results should be analyzed to determine whether or not assumed groupings of users were valid.

B. Track density - symbol clutter and overlap. Where a large number of track symbols are concentrated in close proximity, the symbols will overlap and some symbols will be partially or entirely occluded. This problem is likely to be particularly acute where land, sea, and air contacts may be in very close proximity. The problem will also be exacerbated if the total screen area occupied by a single symbol is increased through the addition of tags, text fields, and modifiers. Tests of the effects of symbol clutter and overlap have been carried out by the US Navy Research and Development Center (NRaD), and the results are currently being analyzed. Definition of MIL-STD-2525 testing in the area of high track density, clutter and overlap should await the outcome of the NRaD studies.

C. Symbol size and color contrast.

(1) Symbol size. Effective use of a symbol set requires sufficient symbol size and color contrast for legibility. MIL-STD-2525 calls out a symbol frame minimum dimension of .25 inches. At 72 pixels per inch, this provides about 18 lines through the target that is adequate for recognition, with 10 to 12 lines through the minimum dimension of the target being widely regarded as a minimum requirement. The MIL-STD-2525 requirement for icon size is .17 inches which corresponds to 12 lines through the target and also meets the resolution requirement. Although not tested, Navy studies (reference t) have in essence validated 23 pixel symbols (including frame), indicating that MIL-STD-2525 symbol size should be adequate. If icon size reduction is contemplated to take advantage of increasing resolution, then the proposed minimum size for symbols should be tested. In addition, Service requirements for larger or smaller symbols needs to be identified. A defined symbol hierarchy developed to accommodate a range of complex to simple symbols should be tested to determine optimal sizes.

(2) Color Contrast and Interaction with the Background. MIL-STD-2525 calls out five colors for identity coding and black for icons, text, lines, boundaries and area outlines. Presumably, de-saturated brown and blue will be used for land and sea areas respectively. If so, the contrast of blue Friendly symbols against a blue sea background and the contrast of yellow against a brown background should be evaluated within the discriminability test effort. Dynamic scenarios should be used for testing in which symbols move over various map background colors and test subjects are required to hook selected tracks by test questions which contain identity specification. Color coding conventions are associated with map background data. The basic concern is that humans are capable of absolute recognition of about 12 to 15 color code steps. This limit could well be exceeded if color coding conventions external to MIL-STD-2525 are used in displays containing MIL-STD-2525 symbology.

D. Ancillary Track Information. MIL-STD-2525 identifies up to 11 text fields and various graphic indicators which may be associated with the display symbol. Use of all allowed fields and tags with a symbol would increase the displayed image considerably. Testing of this issue would require the use of dynamic scenarios in which the display of ancillary information on the

hooked track or symbol is operable. Five to six levels of symbol text/graphic density should be identified. Test questions might include simple instructions to hook particular track. More complex tactical questions such as "Can you engage the hostile aircraft closing on your force?" might be required to ensure that the subject has to make use of selected items of ancillary information in reaching a correct decision. An analysis of the effects of a number of levels of symbol information available might serve to identify an optimum approach to testing this issue. Additionally, some of the basic aspects of text labels also need to be covered. Questions regarding optimal text font/size for readability, the value of color coding applied to labels, optimal positioning for text information, and the presence or absence of a label on symbol recognition and discrimination need to be addressed.

E. Planned/anticipated positions. MIL-STD-2525 makes provision for the future position of mobile units via dashed outline coding. Presumably, a given mobile track would have a current position symbol with a solid outline and a symbol with a dashed outline indicating an intended position at some time in the future. This would add to the symbol clutter and overlap problem. Future position symbols should be incorporated into the clutter and overlap issue and test effort.

F. Effects of Implied Symbol Direction and Symbol Orientation. In the conventions associated with US Army Field Manual (FM) 101-5-1, land weapon symbols can be shown in an orientation consistent with their direction of fire. This issue was also raised in the subject comments from the US Navy SPAWAR STANAG 4420 ratification study (reference i). Some subjects considered it to be confusing that the symbols were presented in a standard orientation while the velocity leader could point to any direction and suggested that the symbol "forward direction" be aligned with the velocity header. Numerous human factors engineering studies have shown that performance in recognition of patterns based on shape is significantly degraded when these are presented in random orientations. If orientation of iconic symbols based on current heading is to be allowed in MIL-STD-2525, then the extent of performance degradation associated with random symbol orientation should be included in the scope of discriminability testing.

G. Special Test Issues.

(1) Geometric Borders. MIL-STD-2525 testing must address the issue of the frame shape to be used for "Neutral" and "Unknown." Currently, the square is used to designate "Unknown" and the quatrefoil is used for "Neutral." It has been suggested within the SSMC (Army) that these be reversed. The SSMC recommendation is to include this issue in the operational testing of the MIL-STD.

(2) Framed versus Unframed Civilian Tracks. MIL-STD-2525 testing must address the issue of whether or not civilian tracks will be framed. Discussions within the SSMC raised the issue of whether a civilian track that was designated as a threat should be framed as "Hostile," raising the larger issue regarding the framing of all civilian tracks. The SSMC recommended that this issue be tested and be subsequently resolved based on the outcome of an operational test.

(3) Color Coding for Unknown. The use of yellow or orange for coding unknown tracks must be addressed.

(4) Background Clutter. On most C4I systems, symbols will be positioned over electronic map background displays, presenting a potential clutter problem. The area of complex color symbols on a complex color map backgrounds must be addressed. In addition, standard Defense Mapping Agency (DMA) data used to support fielded systems must be incorporated into this test.